EVALUATION OF NUTRITIONAL VALUES, PHYTOCHEMICAL CONSTITUENTS AND IN VITRO ANTIOXIDANT STUDIES OF SIX INDIGENOUS NIGERIAN PLANTS

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ABSTRACT

Background: Plants are known to contain minerals and many bioactive compounds which provide several health benefits on consumption.

Aim: The aim of present study was to assess the nutritional composition, phytochemical constituents and antioxidant properties of methanolic and ethanolic extracts of *G. kola mesocarp, V.* doniana *stem, fruit and leaf, L. aculeate leaf* and *L. inermis leaf, C. ferruginea* fruit *and P. soyauxii* stem.

Methods: Fully automated Soxhlet solvent extraction technique was used using ethanol and methanol. Solvent-Solvent fractionation was also done to obtain purer form of the plants extracts using Ethylacetate, N-hexane and N-butanol. Standard methods were employed in the phytochemical screening, quantitative phenols and flavonoid determination and antioxidant assays (DPPH radical and ascorbic acid were determined). Solutions of ascorbic acid and gallic acid served as positive controls. Data obtained were analysed using paired t-tests and one-way Analysis of variance (ANOVA) as well as Pearson Correlation with statistical significance set at < 0.05.

Results: Alkaloids, saponins, terpenoids, carbohydrates and flavonoids were detected in the extracts of studied plants. *V. doniana* leaves had the highest phenolic content (2684.47±55.62 mg/g) in terms of gallic acid equivalents (GAE), From all extracts assayed, *V. doniana leaf* extract was observed to have the highest antioxidant activity with IC_{50} value of 94.48.

Conclusion: The result of this investigation suggests that these plants could be used as wild edible plants, and the natural antioxidants be incorporated as functional ingredients of food.

Key words: *Wild plants, proximate composition, phytochemical constituents, antioxidant properties.*

Introduction

Wild plants have been playing a very momentous role in human life for thousands of years. They have been used for food, medicine, fiber and other purposes and also as food for domestic animals [1]. They have occupied a unique place as they are rich sources of essential minerals, vitamins and bioactive compounds which have several health benefits [2,3].

Plants contain many phytochemicals such as alkaloids and phenolic compounds in addition to nutrients such as minerals, vitamins, proteins and carbohydrates, and several studies have shown that consumption of fruits, vegetables and plant derived food products have health benefits against chronic diseases including cardiovascular disease and certain types of cancer [3, 4, 5]. More than 900 different phytochemicals have already been identified in foods and in just one vegetable or plant food, more than 100 different phytochemicals are found to be present [6]. Many of these phytochemicals have antioxidant properties and support in protection of cells against the oxidative damage caused by reactive oxygen species [7, 8]. Antioxidants are the molecules which have the ability to scavenge or inhibit the oxidation of other molecules. Oxidation reactions can generate reactive oxygen species like oxygen free radicals which initiate chain reactions that may lead to formation of unwanted products or cell damage causing many diseases such as cancer, arthritis, diabetes, and other diseases related to humans [9,10,11].

Phytochemicals such as polyphenols and other bioactive compounds can prevent these chain reactions by scavenging free radicals and obstruct oxidation of other biomolecules [12, 13]. These phytochemicals provide endless prospects for new drug development due to the unmatched availability of chemical variety and plant derived food products are considered to be less toxic and more free from the side effects than synthetic drugs [14]. According to World Health Organization (WHO), 80% of the world's population still depends on traditional remedies for their medicines which have compounds derived from plants. The massive traditional knowledge of medicinal plants is presently playing a very essential role in the development of new drugs.
However, six indigenous Nigeria plants studied includes; *G. kola* mesocarp*, V.* doniana *stem, fruit and leaf, L. aculeate leaf* and *L. inermis leaf, C. ferruginea* fruit *and P.soyauxii* stem.

Garcinia kola Heckel (Clusiaceae), commonly known as bitter kola is a widespread tree of evergreen forest valued in Nigeria for its medicinal nuts which has led to its exploitation in the natural forests [15]. *G. kola* stem and bark has been shown to contain a complex mixture of phenolic compounds such as tannins, guttiferin [16], biflavonoids, xanthenes, benzophenone, kolaflavanone and *Garcinia* flavanone [17] all of which have antimicrobial activity. *G. kola* mesocarp (fruit part) also contains alkaloids, anthocyanins, quinines and anthraquinones [18]. *Vitex doniana* (Verbanaceae) is a tropical fruit bearing tree widely distributed in West Africa and high rainfall areas. It is commonly known as Fon or Ewe oyi by traditional healers and plants sellers in Bénin [19].

It is also widely distributed in Eastern, Western and Northern parts of Nigeria as a perennial tree, the plant commonly called black plum or African olive (English). It is locally called Uchakoro (Igbo), Ori nla (Yoruba) and Dinyar (Hausa), [20]. Chemical constituents of the plant include glycosides, flavonoids, alkaloids, essential fatty acid [21]. The presence of flavonoids in this plant extract explains its antioxidant activity. Flavonoids are potent water-soluble antioxidants and free radical scavengers which prevent oxidative cell damage and have strong anticancer activity. Flavonoids also lower the risk of heart diseases [22, 23]. *Lantana aculeata* is a well known medicinal plant in traditional medicinal system and recent scientific studies have emphasized the possible use of *L. aculeata* in modern medicine [24]. It is a flowering ornamental plant belonging to the family Verbenaceae.

Different parts of *L. aculeata* are reported to possess essential oils, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, iridoid glycosides, phenyl ethanoid, oligosaccharides, quinine, saponins, steroids, triterpens, sesquiterpenoides and tannin as major phytochemical groups [25]. *Lawsonia inermis* (Henna) is a medicinal plant that is widely distributed across the Northern and Southern parts of Nigeria [27]. *Lawsonia inermis* is used as a kind of natural dye and is used as a raw material for natural hair dye [28]. The use of *L. inermis* as counter stain has been reported [29]. The plant contains substances such as lawsone (principal colouring matter), gallic acid, glucose, mannitol, fats, resin, mucilage and traces of an alkaloid. The leaves extract of *L. inermis* also contain phytochemicals such as glycosides, phytosterol, tannins, steroidal compounds and flavonoids[30].

The presence of flavonoids explains the antioxidant property of this plant extract. *L. inermis* leaves, flower, seeds, stem bark and roots have been found to exhibit antioxidant, antidiabetic, hepatoprotective, hypoglycemic, antimicrobial, anticancer and wound healing properties [31]. *Cnestis ferruginea* (Connaraceae) is a shrub or climber of deciduous forest and secondary scrubled widely dispersed in West Africa and other tropical parts of Africa and bears orange-red fruits with velvety hairs on the follicle [32]. Common names of the plant in Nigeria include "Fura amarya", "otito" (Hausa); "Okpu nkita", "amunkita" (Igbo); and "Akara oje", "Bonyin bonyin" (Yoruba); and"Ukpo-ibieka" (Edo).

The plant is about 3.0-3.6m high with densely, rusty brown, pubescent branches, indecidous leaves with more or less alternate or sometimes opposite, ovate to narrowly oblong leaflets. *Pterocarpus soyauxii* is a 30-55 feet high rain forest tree. It belongs to the Papilionaceae family, branch of spermaphytes [33]. The plant stem bark, greyish brown to brown-colour, scales off in fine irregular scales and contains a red sap. Other common names are mukwa or narra. Hence, this study is to evaluate the nutritional values, phytochemical constituents and in vitro antioxidant studies of six indigenous Nigerian plants.

Materials and methods

Design of study

Random sampling was adopted for this study because of the geographical locations and distributions of the different plants.

Collection of Plants

Six indigenous plants were used which were collected across three different states in the Southern region of Nigeria, namely: Edo, Delta and Anambra states. The plants are *Garcinia kola, Vitex doniana, Lantana aculaeta, Lawsonia inermis, Cnestis ferruginea and Pterocarpus soyauxii*. The six plants were collected as follows: *Lawsonia inermis* leaf and *Lantana aculata* leaf were collected in Edo State, *Cnestis ferruginea* fruit was obtained from Delta State, *Garcinia kola* fruit *and Pterocarpus soyauxii* stem, *Vitex doniana* leaf, stem and fruit were collected from Anambra State.

Plant Identification & Authentication

Plants collected were identified authenticated by plant Taxonomists using their local names and standard texts. Samples of plants were deposited in the herbarium of the Department of Plant Biology and Biotechnology University of Benin. Their Voucher numbers are as follows: UBH365 *(Garcinia kola*), UBH366 (*Vitex doniana*), UBH367 (*Lantana aculata*), UBH368 (*Lawsonia inermis*), UBH369 *(Cnestis ferruginea*) and UBH370 *(Pterocarpus soyauxii*).

Study Site

Analysis on the plants parts were carried out in the Faculty of Pharmaceutical Sciences, Agulu, Nnamdi Azikiwe University, Anambra state.

Ethical Approval

The study was approved by the institutional ethics committee at Hospitals Management Board, Benin City, Edo state and Ethical Committee Faculty of Health Sciences (the ethical approval number: (HA 577/VOL.11/173).

Extraction/Processing

Analytical high pressure liquid chromatography (HPLC), Electron Spray Ionisation Mass Spectrometry (LC-ESI-MS) were employed.

Quantitative Analysis of the Constituents

Determination of Alkaloid by Dragendroff's method [34], Determination of saponin content by Frothing test method [35], Determination of Tannin Content by Ferric chloride test method [35], Determination of Flavonoid Content by Aluminium chloride test method, Determination of Cardiae glycosides by Keller-Killani test method, Determination for terpenoids by Salkowaki test, Proximate Analysis, Determination of Ash Content [35], Determination of Moisture Content [35], Determination of Carbohydrate by Molish test method, Crude Protein Determination by Millions test method [35], Test for Antioxidant Property, DPPH (2, 2-diphenyl-1-picrylhydrazyl) radical scavenging activity[36].

Result

Phytochemical analysis of all sampled plants extracts showed presence of alkaloids, tannin and cardiac glycoside. The only extract observed to contain steroids was *L. aculaeta leaf extract,* while terpenes were only detected in *L.* inermis leaf extract, while *G. kola mesocarp extract* was the only extract observed to have very low content of flavonoids (Table 1).The highest concentration of alkaloids, saponin, tannin, flavonoid, was observed in *C. ferruginea fruit*, *L. aculata leaf, V. doniana leaf* and *C. feruginea fruit* respectively (Table one).

However, the HPLC analysis of *L. inermis leaf ex*tract from n-hexane solvent fraction yielded five major compounds identified as Luteolin-5-0-glucopyranoside, Apigenin-5-0-glucopyranoside, Kaemferol-3-0-glucoside, Leuteotine and Apigenin (Figure 1).

Pterocarpus soyauxii analysis revealed four major compounds namely: Malvidin 3-phydroxybenzoylsophoroside, Malvidin 3-acetylatedsophoroside, Malvidin and Tectoridine (Figure 2).

The DPPH method is widely used for screening antioxidant activity of plant extracts. DPPH is a stable free radical having a characteristic absorption at 760 nm. With reference to antioxidant activity, their activities increased with increasing concentration of extracts and standard (Vitamin C). The IC_{50} values of the extracts and Vitamin C were calculated from the percentage inhibitions at various concentrations.

The IC_{50}values are presented in figure four (4). Analysis of total phenolic content of plant extracts as shown in Table three (3) shows that *V. doniana* leaves had the highest phenolic content (2684.47±55.62 mg/g) in terms of gallic acid equivalents (GAE), while the next higher value was found in *G. ferruginea* (971.47±15.03 mg/g), *P. soyuaxii stem* (728.92±13.40 mg/g), *L. aculata* (670.76±5.37 mg/g), *L. inermis* (517.57±14.49 mg/g), *G. kola* (406.93±17.85 mg/g), *V. doniana fruits* (261.30±2.83mg/g), and *V. doniana stem* (189.91±17.10 mg/g).

From all extracts assayed, *V. doniana leaf* extract was observed to have the highest antioxidant activity with IC_{50} value of 94.48. The least antioxidant activity was observed with extracts of *V.doniana stem* with IC_{50}value of 34375.52. This is presented in Table four (4).

The correlation between antioxidant activity and TPC (total phenolic content) in Figure four point eleven, obtained by plotting $1/IC_{50}$ (ml/mg) against TPC (mg/g) showed that the phenolic compounds are responsible for DPPH free radical scavenging of the extract

Table 1?Qualitative Analysis of Phytochemical Composition of Six Tested Indigenous Plants Parts'

Plant Part/Extract	Alkaloid	Saponin	Tanin	Flavonoid	Steroids	Terpenes	Cardia glycosides
Ethanolic solvent							
G. kola mesocarp	+	+	+	+	–	–	++
V. doniana stem	+	+	++	++	–	–	++
V. doniana leave	++	++	++	++	–	–	++
V. doniana fruit mesocarp	++	++	++	++	–	–	++
Lantana aculata	+	+++	++	++	++	–	+
Lawsonia inermis	+	++	++	+	–	+	+
Cnestis ferruginea fruit	++	–	++	+	–	–	++
Methanolic solvent.							
Pterocarpus soyauxii stem.	+	+++	++	++	–	–	+

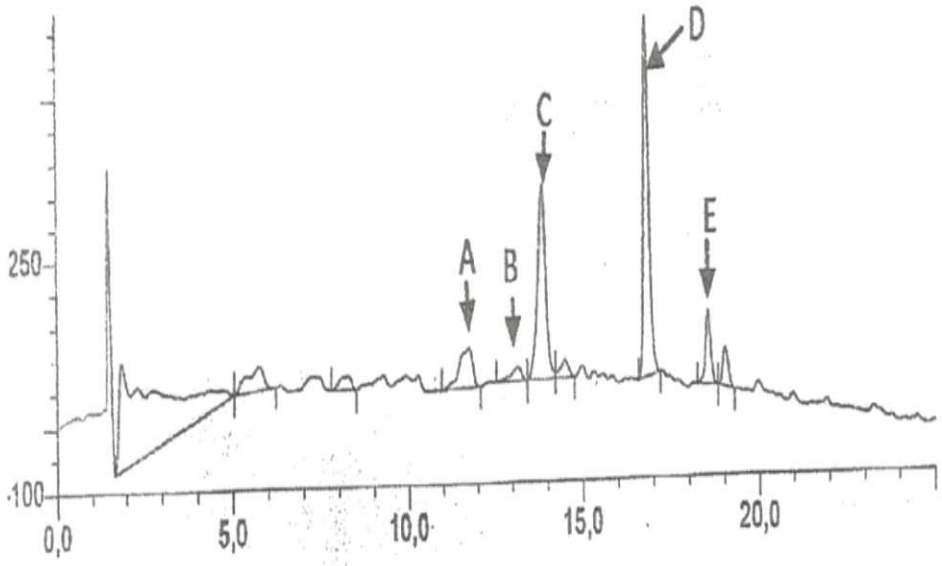
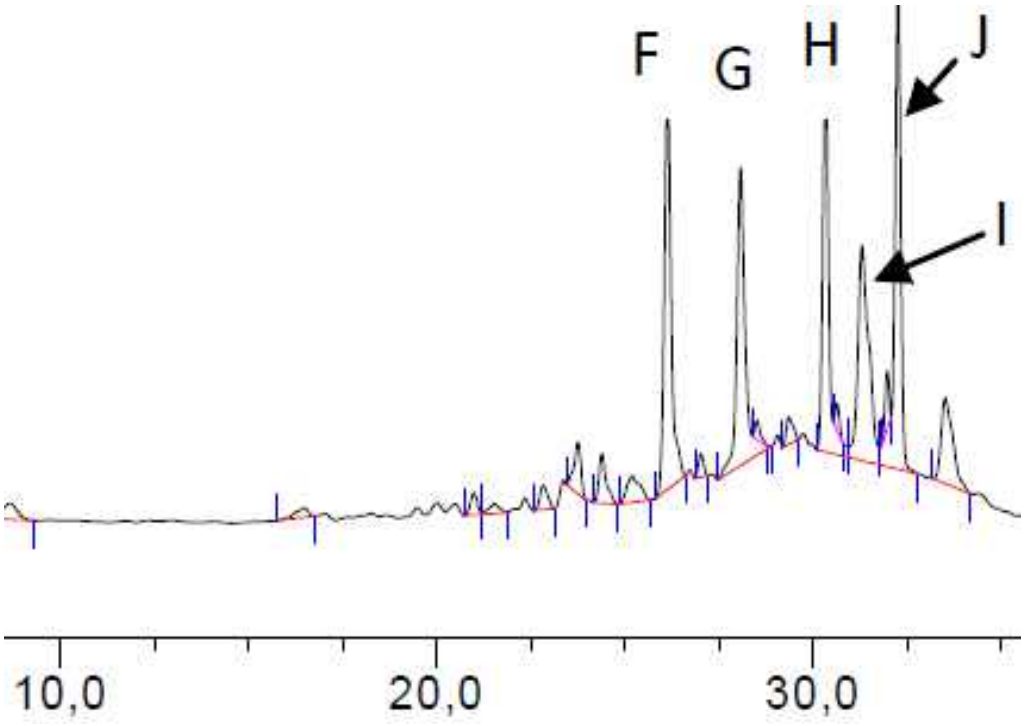
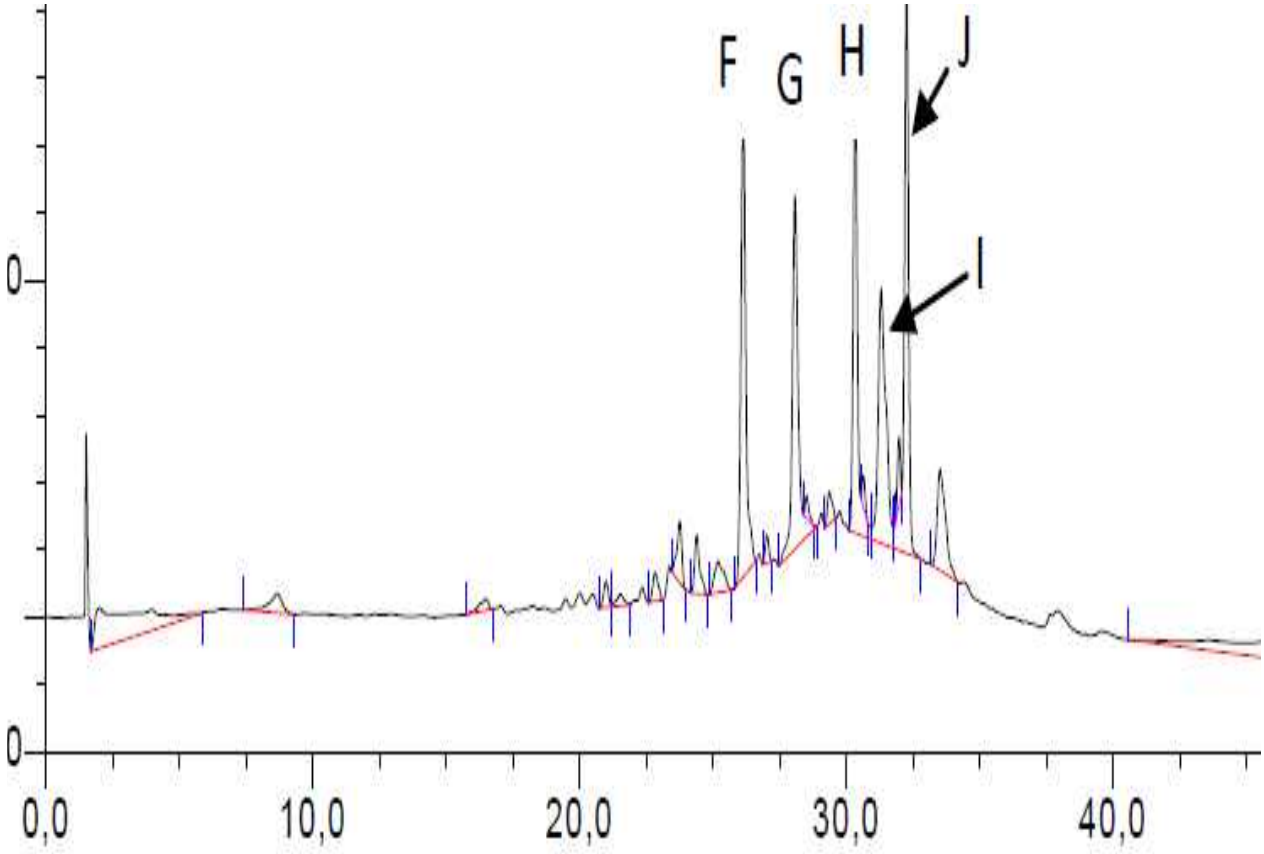


Figure 1: Components of *L. inermis* on HPLC



K= Malvidin 3-phydroxybenzoylsophoroside; L= Malvidin 3-acetylatedsophoroside; N= Malvidin; O= Tectoridine

Figure 2: Components of *P. soyauxii* on HPLC



F=Tectorigenin, G=Peonidin 3-(6”-p-hydroxybenzoyl) glucoside, H=Tectorigenin 3-p-hydroxybenzoyl-5-frulate, I=Peonidin 3-(6”-p-methoxybenzoyl) glucoside, J=Tectorigenin 3-(6”-p-methoxybenzoyl glucoside.

Figure 3: Components of *V. doniana fruit* on HPLC

Table 2. Quantitative analysis of Phytochemical Screening and Nutritional Composition of Six Tested Indigenous Plant Parts

S/N	Plant Extract	Alkaloid (%)	Saponin (%)	Tanins (%)	Flavonoids (%)	Total Ash (%)	Moisture content (%)	Crude fibre (%)	Lipid (%)	Carbohydrate (%)	Protein (%)
1	*G. kola*	11.4	5.3	2.94	1.2	2.5	12.5	51.4	15.4	4.5	1.0
2	*V. doniana stem*	2.4	15.0	2.27	2.7	1.5	8.3	82.4	2.8	5.5	8.4
3	*V. doniana leaves*	0.2	3.79	4.91	9.5	8.5	6.0	41.8	3.2	12.4	1.4
4	*V. doniana fruit*	9.4	10.2	3.31	11.4	13.0	7.8	51.4	5.2	15.4	16.8
5	*L. aculeta leaf*	7.8	17.5	3.18	6.9	17.5	4.2	35.0	10.0	74.9	2.5
6	*L. inermis leaf*	4.2	11.2	3.2	9.1	6.5	4.0	28.6	10.6	46.3	2.10
7	*C. ferruginea fruit*	24	1.28	1.28	12.8	3.5	9.0	30.2	4.8	45.4	1.75
8	*P. soyauxii stem*	21	10.7	2.14	9.6	2.5	5.0	79.2	3.6	52	1.4

Table 3. Absorbance of Standard Compound (Gallic Acid)

Concentration (Mg/ml)	Absorbance (Mean) Λmax = 760nm
1.6	0.0448
3.12	0.0500
6.25	0.787
12.5	0.1129
25	0.1930
50	0.3874

TABLE 4. Total phenolic content of six tested indeginous plant extracts

Plant extracts	Total Phenolic Content (mgGAE/g extract)
G. kola mesocarp	406.93 ± 17.85
V. donnana stem	189.91 ± 17.10
V. doniana fruit	261.30 ± 2.83
V. donianna leaf	2684.47 ± 55.0
L. aculata leaf	670.76 ± 5.37
L. inermis leaf	817.57 ± 14.49
C. ferruginea fruit	971.47 ± 15.03
P. soyauxii stem	728.92 ± 13.40

Discussion

Phytochemical analysis of *G.kola* mesocarp revealed alkaloids, saponins, tannins and cardiac glycoside as constituent parts. Similar work had been done in another study in Congo which reported saponin, alkaloids, tannins and flavonoid as intergral part of *G. kola* mesocarp extract [37]. Their findings are in agreement with this very study, except cardiac glycosides which was found only in this study. This may be as a result of differences in geographical location of the two studies. Phytochemical composition indicated that *G. kola* mesocarp has good chemotherapeutic value. Also the nutritional composition of *G. kola* mesocarp extract showed similar findings. It had very low protein content (1.0%) and crude fibre. The low protein content observed in *G kola* mesocarp in this study and that of Morabandza *et al.,* (2013) shows that *G. kola* mesocarp as not a good source of protein. Low concentrations of saponin (5.3%) and flavonoid (1.29%) were recorded in extract of *G. kola* mesocarp in this work. Furthermore, no other study however, has been carried out to the best of my knowledge on *G. kola mesocarp.*

All the *V. doniana* parts studied (leaf, stem and fruit), *V. doniana* fruits was observed to have the highest protein content of 16.8%. Indeed, of all extracts studied, *V doniana* fruit was found to have the highest protein content. This finding has great implication for its use as a rich protein source. All parts of *V doniana* (stem, leaf, and fruit) used in this study were observed to contain alkaloids, flavonoids saponin, tannins, and Cardiac glycoside. Contrasting findings to that of this work has also been reported by study conducted by [38], which also did not report saponin and terpenes as counstituent parts of *V. doniana* stem and leaf.

A vast array of phytochemical constituents was detected in the extract of *L. aculaeta* leaf. Indeed it is the only plant extract that Terpenes was found out of the eight extracts assayed. In a recent Indian study carried out on *L. aculaeta* leaf, a host of compounds were detected ranging from flavonoids, tannins, alkaloids, saponins, steroids among others[38]. In another study conducted in India on *L. aculaeta* root, alkaloids and steroids were not detected. This finding may suggest that leaves of *L. aculata* contain more bioactive compounds than roots. This however will require more investigations to verify. Interestingly in this study, *L. aculata* leaf was found to have the highest carbohydrate and saponin content of all plants extracts assayed making it a good source of energy and anticancer agent.

No steroid was detected in *L. inermis* leaf extract in this study. Phytochemical analysis of *L. inermis* revealed alkaloids, saponin, tannins, flavonoids, terpenes, and cardiacglycoside [39] confirmed the presence of cardiac glycosides, steroids, saponin, tannins and flavonoids. Contrary to findings in this study, no protein was detected in the nutritional composition in the study conducted by [39]. The presence of these constituents in the fruit extract of *C. ferruginea* in this study indicates that it has good pharmacological and therapeutic value. In herbal medicine and some literatures, the fruit extract has diverse therapeutic uses against infections like snakebite, dysentery, syphilis, gonorrhea, cough, dysmenorrhea, ovarian troubles and aphrodisiac. The root and fruit extracts however, prevents abortion, constipation, fever and pain [40,41].

In the HPLC analyses of the six different plants part extracts, the ethylacetate solvent fraction of the *V.doniana fruit,* revealed five compounds which were identified to be Tectorigenin, Peonidin 3–(6-parahydroxybenzyl) glucoside, Tectorigenin–3–p–hydroxybenzyl–5–frulate, Peonidin–3–(6"– p –methoxybenzoyl) glucoside and Tectorigenin –3–(6"–p–methyoxybenzoyl) glucoside . These compounds are generally called flavonoids which are divided into six sub groups, of which these five compounds detected fall into two subgroups: namely; Isoflavones and Anthocyanins. Tectorigenin, Tectorigenin (3–p–hydroxybenzoyl–5–frulate) and Tectorigenin 3–(6"–p– methydoxybenxoyl) glycoside are Isoflavones while Peonidin 3–(6"–p–hydroxybenzol) glucoside and Peonidin 3(6"– p– methoybenzoyl) glucoside are Anthocyanins.

Isoflavones are found in a class of plants known as phytoestrogens because of their similar chemical structure and function to the female sex hormone estrogen; while *Vitex doniana* fruit is rich in isoflavones and the three types of isoflavones discovered have 13.15%, 11.70% and 14.62% respectively as peak area. Isoflavones are widely appreciated and are currently the subject of intense research and discussion, this is because it protects against hormone related disorders such as breast cancer prostate cancer, osteosarocoma, lung carcinoma, and ovarian cancer [43,44].

Anthocyanins are polyphenols and generally accepted as the most important group of water soluble pigment in nature [45]. They are responsible for the blue, purple, red or orange colour of many fruits and vegetables [45].

They are distinguished from other flavonoids due to their capacity to form flavylium cations [46]. One of them is Peonidin found in this study which is responsible for the colour found in *V.doniana fruit* (Purplish blue colour) and this is also influenced by the abundance of hydroxyl group. The hydroxyl is responsible for the bluish shade while the methoxyl influence the reddish colour [47],[48].

Anthocyanins can exert a major chemopreventive activity due to their antioxidant property [49] by scavenging reactive oxygen and reactive nitrogen species or by chelating trace metals involved in free radical production [50].

In the analysis of *lawsonia inermis* leaf extract, the ethylacetate solvent fraction yielded five major compounds identified as Luteolin–5–glucopyranoside, Apigenin–5–0–glucopyranoside, Kaemferol – 3- 0 – glucopyranoside, Luteoline and Apigenin.

Apigenin monoglycosides is also a flavone present in form of glycosides in *Lawsonia inermis* with peak area of 1.35% concentration. Apigenin suppresses cancer cells, by altering a very specific step in gene regulation making cancer cells to die like normal cells. Apigenin also binds a very important protein called HnRNPA2 and this connection thus inhibit breast cancer cells and so cells die in programmed way (Restors the single splitting of cells instead of double splitting which is a characteristics of breast cancer cells (induces apoptosis). It also has anti-inflammatory properties. It blocks the production of uric acid. It has antidepressant-like effect. Some other sources of Apigenin are found in thyme, peppermint, chamomile herbs, red wine and tomatoes sauce.

Kaempferol monoglucoside, this is a flavone, present at a high percentage (peak area) as 14.87% in *lawsonia inermis* leaf extract, it is a natural flavonol a type of flavonoid, and appear as a yellow crystalline solid, this contributes to the yellow colour exhibited by *Lawsonia inermis leaf extract*. Kaempherol is also found in apples, grapes, tomatoes, broccoli, cucumbers, letuce, green beans and moringa. It is a strong antioxidant and it combines with quecitin to reduce proliferation of cancer cells [51, 52]. It is a potent promoter of apoptosis [53]. In Chemotherapy it is much less toxic to normal cells in comparison with standard chemotherapy drugs[54].

The n-hexane solvent fraction of *Pterocarpus soyauxii* yielded six different compounds. The four compounds identified were: Malvidin 3-p-hydroxylbenzolsophoroside, Malvidin 3-acetylatedsophoroside, Malvidin and Tectoridine.

Malvidin is an anthocyanin (flavonol) in the group of flavonoid (polyphenol) found abundantly in berries (bilberry and blueberry). The diversity of anthocyanins are due to the number and position of hydroxyl and methoxyl groups on the basic anthocyanidin skeleton; the number and positions at which sugars are attached, and also the extent of acylation and the identity of the acylating agent. The intensity and type of the colour of anthocynins is affected by the number of hydroxyl groups: if more methoxyl prevail, then redness increases [48].

With reference to antioxidant activity, their activities increased with increasing concentration of extracts and standard (Vitamin C). The IC_{50} values of the extracts and Vitamin C were calculated from the percentage inhibitions at various concentrations.

The correlation between antioxidant activity and TPC obtained by plotting 1/IC50 (ml/mg) against TPC (mg/g) showed that the phenolic compounds are responsible for DPPH free radical scavenging of the extracts. Antioxidants in the extracts react with DPPH and convert 1, 1-diphenyl-2- picrylhydrazyl (deep violet color) to 1, 1-diphenyl-2-picrylhydrazine, a stable molecule (yellow color or bleached product) by accepting an electron or hydrogen radical at a very rapid rate resulting in a decrease in absorbance at 760 nm [10]. IC50 value is defined as the inhibitory concentration of the crude extract that scavenges 50% of reactive oxygen species or inhibits the process of oxidation by 50%. It is inversely related to antioxidant capacity and lower IC50 value signals better antioxidant activity. In this investigation, all the plant extracts were compared with ascorbic acid as standard reference. From all extracts assayed, *V. doniana leaf* extract was observed to have the highest antioxidant activity with IC_{50} value of 94.48. The least antioxidant activity was observed with extracts of *V.doniana stem* with IC_{50} value of 34375.52.

Conclusion

Some of these plants have been evaluated for the first time and these plant extracts contain some bioactive compounds namely: flavonoids, alkaloids, steroids, tannins, cardiacglycosides saponins, terpenes, and nutrients such as carbohydrate, protein, crude fibre, lipid, total ash moisture, and have relatively strong antibacterial properties and also antioxidant activities which are associated to free radical scavenging activities. Hence, the plants could be good sources of nutritional value and natural antioxidants in improving malnutrition problems, combating many human deficiency diseases and could also be developed as drugs for the prevention and treatment of diseases especially caused by oxidative stress. However, further study on mineral contents of these plants should be done using Atomic Absorption Spectrometer.

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